Volume 095
Article 06

FISHERY RESEARCH

Job Performance Report
Project F-73-R15

WILD TROUT EVALUATIONS

Subproject II, Study IV

Job 3b. Angler Compliance with Special Regulations

by

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IDFG 94-12
April 1994

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JOB PERFORMANCE

State of: Idaho

Name: Wild Trout Evaluations

Project No: F-73-R-15

Title: Angler Compliance with Special Regulations.

Subproject: I

Job: 3b

Study: IV

Period Covered: April 1, 1992 to March 31, 1993

ABSTRACT

Idaho fishing regulations require various levels of restraint from the fishing public. Compliance with special regulations is assumed when developing regulations but may not occur. We used Random Response (RR) to estimate compliance with fishing regulations. RR is a technique designed to gather unbiased data on sensitive issues that could criminalize individuals. In this study we recalculate estimates of non-compliance estimated in past random response surveys for two Idaho waters, conduct a pilot study on two additional waters and provide a review of the technique and possible use by Idaho Department of Fish and Game. Review of a 1981 study on the Coeur d'Alene River and recalculation of the estimate lowered estimates of non-compliance with a bait restriction and a minimum size limit substantially but levels were likely still excessive for successful management (36 and 24%, respectively). Recalculation of past Middle Fork Boise River estimates resulted in much better compliance estimates as well. Three of six revised estimates resulted in negative compliance estimates however, suggesting either random sampling error or angler suspicion about privacy protection.

Results of pilot studies done in 1992 suggest that compliance with regulations on the South Fork Payette and Coeur d'Alene rivers is good but more intense sampling is needed. The technique appears to hold promise for fish and game agencies attempting to quantify poaching losses and resultant biological affects. Possible benefits of RR surveys include re-allocation of enforcement manpower and direction of education efforts towards groups with higher violation rates.

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INTRODUCTION

Fishing regulations typically require various levels of restraint from the public. The Idaho statewide general limit of six fish requires little sacrifice for most harvest-oriented anglers because few fishermen exceed such a bag limit in a typical angling day (Thurow 1990). Special regulations often require anglers to alter gear used (bait restrictions, barbless hooks, etc.) and release much of the catch. An individual angler may or may not choose to comply with such restrictions, but special regulations typically result in increased fish sizes, densities, and angler catch rates (Behnke 1987; Wydoski 1977; Anderson and Nehring 1984).

Perhaps because of the success of special regulation areas, 100% angler compliance is often assumed when developing regulations for individual waters. Angler compliance is typically not considered or even mentioned in regulation modeling exercises (Thurow 1990; LaBolle and Schill 1988; Espegren et al. 1990; Clark 1985).

In fact, angler non-compliance with regulations could effect the success of special regulations (Paragamian 1984). Gigliotti and Taylor (1990) demonstrated via simulation, that a relatively small amount of angler non-compliance could effect stock structures and densities in a typical catch-and-release fishery. Lewynsky (1986) concluded that angler non-compliance was a factor in the limited response of the wild cutthroat trout Oncorhynchus clarki stock in the North Fork Coeur d'Alene River to special regulations.

Thus, even though special regulations have improved fisheries above an over harvested state, the population may not reach management goals if compliance is poor. In the case of the Coeur d'Alene River, it is unclear if non-compliance continues to be a limiting factor or if problems with habitat quality (Gamblin 1987) is the principal factor limiting the fishery. Additional data on angler compliance would assist in the allocation of limited resources to improve this fishery which has not met management goals.

Public compliance with fish and game laws is difficult to assess. Violators often successfully hide evidence of violations from enforcement personnel during routine contacts. Estimates of compliance based on routine contacts can be misleading (Cowles et al. 1979). Several techniques including undercover contacts (Smith and Smeltzer 1991), clandestine observations (Rohrer 1991), violation simulation (Stork and Walgenbach 1973) and Random Response (RR) (Lewynsky 1986; Rohrer 1991) have been used infrequently to estimate non-compliance with fishery regulations. The RR technique has received minimal attention despite promise shown in a few studies.

A large volume of literature, primarily in statistical journals, describes RR as a technique to gather unbiased data on sensitive issues that could embarrass or criminalize individuals. The initial RR concept reported by Warner (1965) involves asking a respondent whether he is a member of stigmatizing group A or compliment group B; e.g. I am a poacher, I am not a poacher. A randomizing device provides privacy by denying the interviewer knowledge of which question the respondent is answering.

Greenburg et al. (1969) later introduced the Unrelated Question Randomized Response design. This model incorporates two unrelated questions, one potentially stigmatizing, and one completely benign. Examples of the two questions are "Have you used illegal drugs in the past year?" and "Were you born in the month of April?" Numerous authors have demonstrated the statistical superiority of the unrelated question model over the Warner model (e.g. Greenburg et al. 1969; Horvitz et al. 1976).

The original un-related question model requires two independent random samples. The probability of respondents being asked the sensitive versus the unrelated question is determined by the randomizing device *in* both samples. In the first sample, respondents are asked to answer a sensitive question with probability = P and the unrelated question with probability (1-P). In the second sample, the probabilities of answering the two questions are reversed. Using this data the true proportion of individuals answering yes to the sensitive question $_{(IrA)}$ can be estimated (Greenburg et al. 1969).

Numerous authors (e.g. Greenburg et al. 1969; Horvitz et al. 1976; Moors 1971; Folsom et al. 1973) expanded on the general unrelated question model. Greenburg et al. (1969) pointed out that selecting an un-related question in which the probability of obtaining a yes response ($\tilde{n}_y$) is known is superior to the above model and requires a single random sample to estimate $'N_A$. For example, if we wanted to estimate the proportion Ada county residents who illegally fished with multiple rods last season, an appropriate unrelated question might be "were you born in the month of April?" This probability could be obtained from license records, would eliminate the need for a second sample, and would reduce the variance around the poaching estimate.

Another method for developing a known value for vey was first suggested by Mr Richard Morton of Sheffield University and first developed in Greenburg et al. (1969). Using this approach, the unrelated question is replaced by forced yes or no responses depending on the outcome of the randomization device. The technique, later dubbed a contamination design by Boruch (1972), results in a subsample of individual respondents answering yes or no to an interviewer regardless of their truthful response for the stigmatizing question. In essence, some of these individuals are "forced" to lie in order to provide privacy for others in the survey. The advantage of this technique is the elimination of the second sample in the survey and development of a known value for $\tilde{n}_y$.

Lewynsky (1986) and Rohrer (1991) both used a contamination design RR survey to estimate regulation violations in two Idaho special regulation waters. These studies reported that non-compliance with some regulations may exceed 50%. Based on literature review, however, statistical errors positively biased their estimates.

OBJECTIVES

1. To recalculate estimates of non-compliance for the Coeur d'Alene and Middle Fork Boise rivers from existing data.

2. To estimate non-compliance on two additional Idaho waters.

3. To provide a review of the random response technique and its applicability for assessing fish and game violations for Idaho Department of Fish and Game (IDFG).

DESCRIPTION OF STUDY AREA

North Fork Coeur d'Alene River

The stream originates on the Pend Oreille divide near the Montana border and flows southwesterly for approximately 190 km until entering Coeur d'Alene Lake. Roads parallel major streams with the exception of Independence Creek and the upper reaches of the mainstem (Lewynsky 1986). Westslope cutthroat trout Oncorhynchus clarki lewisi and mountain whitefish Prosopium williamsoni are the predominant gamefish species.

IDFG has used special regulations to manage for higher densities of wild cutthroat trout since the mid-1970s. A three-fish bag and 300 mm size limit was placed on that portion of the river upstream from Yellow Dog Creek from 1975-85. A lack of response in the population prompted more stringent regulations in 1986. The current regulations include a one-fish >355 mm minimum size on a segment from the confluence with the South Fork Payette River to Yellow Dog Creek, and catch-and-release only with single barbless hooks on that portion upstream from Yellow Dog Creek. Bait is not excluded on the lower section but is prohibited within the catch-and-release zone.

South Fork Payette River

The stream originates on the western face of the Sawtooth Mountains in central Idaho and flows west to its confluence with the North Fork Payette River at Banks. A road parallels much of the stream with the exception of the headwaters and a lower canyon section. Predominant gamefish species include wild rainbow trout Oncorhynchus mykiss and mountain whitefish.

In 1992, IDFG implemented a two-fish bag limit on that portion of the stream above Eightmile Creek as part of the new statewide wild trout regulation. Gear type and bait are not restricted.

Middle Fork Boise River

This stream originates on the western face of the Sawtooth Mountains and flows west to Arrowrock Reservoir near Boise. Much of the mainstem is roaded with the exception of upper reaches. Predominant gamefish species include wild rainbow trout and mountain whitefish.

Rohrer (1989) documented exploitation of 65% for wild rainbow trout >200 mm and recommended special regulations to enhance the fishery. The regulation (one fish >355 mm) was implemented during the 1990 season.

METHODS

General Model

We calculated all non-compliance estimates in this study using a contamination model. We used a deck of 20 cards as a randomizing device after Lewynsky (1986). Fourteen individual cards in the deck contained a question in regard to compliance with a specific regulation (e.g., "Have you ever used bait on the catch-and-release zone of this river?"). Three cards were simply marked "say yes to the interviewer" and three cards were marked "say no to the interviewer" (Lewynsky 1986).

We used the format of Lewynsky (1986) in the interview process. We showed participants the three types of cards in the deck and explained carefully the need for forced yes/no responses to protect individual privacy. We asked them to shuffle the deck and remove one card at random. They responded to the card as appropriate, returned it to the original deck and re-shuffled it before returning the deck to the interviewer. We repeated this procedure with several other decks that pertained to other restrictions on the waters if appropriate. For example, we sought to determine whether anglers were complying with bag limits, minimum sizes, and bait restrictions on a segment of the Coeur d'Alene River using three separate card decks.

Prior to commencing surveys, we explained the study purpose to participants. In the case of the North Fork Coeur d'Alene River, a major objective of the survey was to identify the major factor preventing special regulations from achieving management goals (angler non-compliance vs habitat). In the case of the Middle Fork Boise River and South Fork Payette River surveys, we sought information on angler compliance with regulations during their first year of implementation. We assured anglers that individual compliance was not of interest to us, but that by sampling a large number of anglers, an overall compliance rate could be derived.

To expect honest responses from violators, anglers must clearly understand how they are afforded privacy. We stressed that the interviewer had no knowledge of which card had been drawn and that a yes answer did not identify them as a violator because of the "forced" yes cards in the deck. For those who appeared confused we made a practice run using a hypothetical example.

We calculated non-compliance estimates with specific regulations using the RR formula of Greenberg et al. (1969) where the unrelated characteristic is known:

$$\Pi_A = \frac{\hat{\lambda} - (1-P)\Pi_Y}{P} \qquad (1)$$

with variance =

$$\frac{\lambda(1-\lambda)}{nP^2} \qquad (2)$$

where:

Π_A = estimated proportion of anglers violating the regulation in question.

$\hat{\lambda}$ = proportion of yes answers in the survey.

P = probability of selecting the regulation question from the card deck = 0.7.

$\Pi_Y = P_2/(P_2+P_3)$ = the proportion of respondents with the non-sensitive attribute (Horvitz et al. 1976) where: (3)

P_2 = number of cards in the deck requesting the respondent to say yes to the interviewer.

P_3 = number of cards in the deck requesting the respondent to say no to the interviewer.

$\lambda = P(\pi_A)+(1-P)\pi_Y$ = probability of receiving a yes answer in the survey (Greenberg et al. 1969). (4)

We approximated 95% confidence limits using the formula:

$$2\sqrt{variance} \quad (5)$$

1992 Studies

North Fork Coeur d'Alene River

During 1992 on two three-day periods (including a weekend in June and July), a single interviewer surveyed all anglers observed on the two special regulation sections of the stream. Anglers were asked to participate in the procedure described above.

On the Catch-and-Release segment (Yellow Dog Creek to headwaters), we sought responses from individual anglers for three separate components of the regulation. One card deck included the question, "Have you ever used bait?" The sensitive question in the second deck was, "Have you ever kept trout?" The question in the third deck was "Have you ever used barbed hooks?" Immediately before starting the process we reminded anglers of regulation implementation dates, described boundaries and stressed that the questions pertained only to the special regulation water they were fishing.

On the remaining segment of the stream (South Fork Coeur d'Alene River confluence to Yellow Dog Creek), we sought to address non-compliance with both the bag and minimum size limits. The sensitive question in deck one was "Have you ever kept a cutthroat trout under 14 in?" The second deck addressed the question "have you ever kept more than one cutthroat trout in one day?" Again anglers were reminded of implementation dates and appropriate boundaries for the regulation.

South Fork Payette River

The sensitive question on the South Fork Payette River was "Have you ever kept more than two trout?" Many of the anglers interviewed were fishing for their first day under the new regulation. Many, therefore, had no opportunity to exceed the two-fish bag limit prior to our survey. In these instances, we modified the sensitive question to, "In the future would you keep more than two trout?" We contacted anglers during structured creel census interviews.

Re-calculation of Past Idaho Estimates

Both Lewynsky (1986) and Rohrer (1991) investigated non-compliance with special regulations via random response techniques. Based on the literature (Horvitz et al. 1976; Chaudhuri and Mukerjee 1988), both authors used incorrect values of ny in the estimates. I re-calculated $\tilde{n}_y$ for their data using equation 3 above.

Raw data on numbers of yes responses were not available from either study. To determine the observed number of yes responses in their work, I substituted their estimates of non-compliance ($\tilde{n}_y$), and the incorrect value of $\tilde{n}_y$ (they used 0.15) into equation 1 and solved for the proportion of yes answers theoretically received in the survey. I recalculated non-compliance using equation 1 and the correct value of $\tilde{n}_y$ (0.5). We compared these adjusted noncompliance estimates with original values reported by Rohrer (1991) and Lewynsky (1986).

RESULTS

1992 Studies

North Fork Coeur d'Alene River

Catch and Release Area-We interviewed 26 individuals in the catch-and-release area. A small percentage (0.5%, 95% CL = t20%) of respondents kept trout illegally based on the model. A relatively high percentage of the same individuals admitted to violation of the barbless hook regulation (33%, 95% CL = t19%). The estimate for the proportion of anglers using bait illegally was a negative number (-5%, 95% CL = ±18%).

One Cutthroat Trout >14 in-In the lower portion of the river an estimated 2% of 32 anglers kept fish less than the legal length limit. We estimated that 5% of the same individuals (95%Cl= t20%) creeled more than one cutthroat trout in violation of the bag limit.

South Fork Payette River

A total of 59 individuals were interviewed. We estimated that 2.8% of the respondents (95% CL = ±14%) had already or would violate the two-fish bag limit.

Recalculation of Past Estimates

North Fork Coeur d'Alene River (1981)

Re-evaluation of data reported by Lewynsky (1986) resulted in substantial declines in non-compliance from his original estimates. Estimated non-compliance with the bait restriction declined from 51% to 36%. Revised estimates of non-compliance with both the minimum size and bag limits declined by the same amount, 15% (Table 1).

Middle Fork Boise River (1990)

Re-calculation of data from Rohrer (1991) also resulted in substantial declines in non-compliance from original estimates (Table 1). Non-compliance rates for individual portions of the regulation declined from a high of 21% to less than 5% using the appropriate data inputs. We estimated a negative non-compliance rate for both the bag and size limits.

DISCUSSION

Non-compliance Estimates

Lewynsky (1986) concluded non-compliance was a major factor in the poor population response to special regulations in effect on the Coeur d'Alene River since 1975. Although re-calculations of his data reduced non-compliance rates by 15% for all three regulations, new estimates for the bait restriction and bag limit were still well above levels desired (Table 1).

Results of the 1992 pilot study on the Coeur d'Alene River are not directly comparable with the 1981 study because of additional regulation changes. Based on the preliminary 1992 data it would appear that use of bait and creeling of trout in the catch-and-release area is minimal. Use of barbed hooks appears to be a much more common violation. On the lower Coeur d'Alene, we estimated that over 95% of the anglers complied with both the creel and length limits.

Table 1. Revised Random Response estimates of non-compliance with special regulations on the Middle Fork Boise (1990) and North Fork Coeur d'Alene rivers (1981). Original data from Lewynsky (1986) and Rohrer (1991).

Special Regulation	% Non-Compliance Original	% Non-Compliance Revised	Revised Confidence interval (a=.05)	n
North Fork Coeur d'Alene				
bait restriction	51	36	(±9)	156
330 mm minimum size	39	24	(±11)	156
3 trout bag limit	10	-5	(±8)	156
Middle Fork Boise River				
bait restriction	21	5	(±11)	97
355 mm minimum size	14	-1	(±10)	97
1 trout bag limit	11	-4	(±10)	97

The small sample size obviously makes any definite conclusions in either zone questionable.

Following the survey, several bait anglers voluntarily disclosed that they kept fish less than 330 mm when they were hooked deep in the esophagus even though they knew it was illegal. The extent of such an attitude on the Coeur d'Alene River is unknown but should be assessed. Schill (1992) suggests that the majority of bait anglers on several other Idaho waters reported cutting the line on deep-hooked fish to improve survival rates. Increased education efforts may be necessary.

A key question in management of this stream is whether or not compliance with special regulations has improved since the 1981 study (Ned Horner, IDFG, personal communication). Results of a combination of conservation officer contacts including 1992 clandestine observations, undercover techniques, and routine patrols suggest that compliance remains poor (Dwain Lowry, IDFG, personal communication). Much of the data is from limited areas often frequented by "poachers" however. We suggest a thorough investigation be conducted in 1993 with contact days and anglers being assigned at random as in Smith and Smelzter (1991).

Results of our survey on the South Fork Payette River suggest good compliance with the two-fish bag limit. Many of the anglers we contacted during the survey had not had an opportunity to violate the new bag limit, however. In these cases, we asked most of the anglers whether they would comply in the future. Such an approach can often yield biased results (Frey 1989). Some individuals may believe they would not violate the bag limit but would not truly know until faced with the opportunity. Thus, a better indication of non-compliance on the South Fork Payette River could be obtained several years in the future when most of the anglers have had an opportunity to violate the regulation.

Recalculation for the Middle Fork Boise River from data in Rohrer (1991) reduced non-compliance estimates considerably (Table 1). Estimated non-compliance with the bait restriction declined four fold. Non-compliance with the minimum size and bag limits declined from 14% and 11%, respectively, to negative values in both cases. The Rohrer survey may suffer from the same potential bias as our Payette study since his survey was done during the first year of the regulation. Since the regulation has been in effect for several years, a more reliable estimate of non-compliance could now be obtained.

A number of the revised and 1992 non-compliance estimates were negative values suggesting questionable model performance. It is possible to obtain negative estimates using RR simply by chance, especially if the true non-compliance rate is low. For example, if very few survey respondents drew directed yes cards, then a negative estimate could occur. This possibility is reduced by increasing the sample size. The Lewynsky sample size is approaching that where chance random error should be minimal but the Rohrer survey (n = 97) is suspect. The small size of our 1992 surveys make random error quite possible.

It is also possible, however, that the negative estimate reflects individuals unwilling to be truthful. During the Middle Fork Boise River study, interviewers were also conducting other work including creel census and enforcement checks (Eric Reiland, personal communication). Under these

circumstances, the negative Middle Fork Boise River estimates are not surprising. During the 1981 Coeur d'Alene study, the interviewer was not in uniform and was not an IDFG employee.

A major flaw in the above work, including the revised and 1992 estimates is the wording of the questions themselves. We followed both Lewynsky (1986) and Rohrer (1991) in using the statement "have you ever" kept illegal fish, used bait etc. This wording could distort non-compliance estimates since an individual may have poached a single time 5 years ago. The violator rate (proportion of those questioned violating in last year) (Smith and Smeltzer 1991) would seem more important in addressing education and/or enforcement issues. A violation rate (say for the last trip) would seem more important for assessing biological effects but would also be of interest to enforcement. Any future RR work should incorporate the latter rate in the question development.

We also followed Lewynsky (1986) and Rohrer (1991) in setting $\tilde{n}_y$ (the proportion of directed yes cards) at 0.5. Greenburg et al. (1969) and Moors (1971) state that for reducing variance and confidence limit size, $\tilde{n}_y = 0.5$ is the most inefficient selection possible. Any future work done, including contamination or unrelated designs should not be done with $\tilde{n}_y$ at this value (see below for discussion of appropriate values).

In addition to Lewynsky (1986) and Rohrer (1991), we found only two other wildlife-related studies that have used RR. Smith (1989) used RR to estimate frequency of fishing without a license in Colorado. An estimated 22% of respondents had fished at least once during the past year without one. Wright (1980) estimated the numbers of Iowa deer poached illegally by farmers alone was about equal to the legal hunter take.

Random Response has received little attention from fish and wildlife agencies, perhaps for several reasons. The methodology is confusing for the average person to comprehend (Smith 1989) and explaining how it protects individual privacy is sometimes difficult. Much of the RR literature is in statistical journals replete with complex mathematical formulas and discussions of variance efficiencies, optimal allocation of sample size etc. (Greenberg et al. 1969; Moors 1971; Folsom et al. 1973) that probably deter biologists from using the method. It has been suggested that even the name Random Response is confusing since it is the question and not the response that is stochastic (Brown 1975; Bourke and Dalenius 1976). These authors suggested the technique be called randomized inquiry. Despite possible confusion, it is not necessary, for survey respondents to understand how the technique works. Anglers must only believe that their privacy is protected in order for RR to work (Smith 1989).

Model Selection and Survey Design

Folsom et al. (1973) provide guidelines for selecting an appropriate RR model:

> "It is always preferable to select a neutral, unrelated question whose frequency in the sampled population is known beforehand. If this is not possible, consideration should be given to the contamination design. When neither of these techniques is feasible, the current

best procedure is to reduce the variance of $\tilde{n}_y$ by using the second sample solely for estimating $n_{Y''}$. Thus the preferred RR models are the contamination design and the technique where $\tilde{n}_y$ *is* known prior to the survey (Greenburg method).

Boruch (1972) compared the efficiencies of these two methods in terms of variance. He concluded that the contamination method is most efficient in certain restricted ranges. Otherwise, the Greenburg method is more efficient. The ability of a method to minimize variance is only one measure of performance however. The ability of the public to understand and/or be at ease with the two techniques is important as well. Boruch (1972) called for comparative work on the two methods but we found no evidence of such studies. Consideration should be given to conducting such work if extensive use of RR is considered by IDFG.

Random Response has been criticized because it requires a larger sample size than direct question methods to obtain a given level of precision (Smith 1989). This is because the randomizing device introduces a second component to the estimated variance. On the South Fork Payette River for example, our RR survey of 58 individuals resulted in a 3% noncompliance estimate with a wide 95% confidence limit of t14%. If we had interviewed the same anglers directly and convinced the violators to answer truthfully with no privacy protection, the confidence limit would have been only t4%.

Sample size needed will depend directly on the level of precision needed to assess biological or sociological effects of non-compliance on the population. Again, using the South Fork Payette River data as an example, the confidence limit for our 1992 non-compliance estimate (3%) was -11 to 17%. To quantify sample size effects, we varied sample size and adjusted the proportion of yes responses accordingly to maintain estimated non-compliance at 3% in formula 1 above. Results of this procedure (Figure 1) suggest that (assuming true non-compliance is 3%) about 200 respondents would have to be surveyed in order to obtain confidence limits within 100% of the estimate. Such a level of precision would surely provide adequate information for management purposes. Little benefit would be gained by increasing the size above that level. This example only applies to the South Fork Payette River estimate of 3%, however. Different levels of non-compliance would require varying sample sizes.

Suggested parameter values have been developed to improve estimate precision, regardless of which design is chosen. The following suggestions are largely from Greenburg et al. (1969). The frequency of yes responses for the non-sensitive attribute must be sufficiently large to allay suspicion in the respondent population. One should choose n_y on the same side of 0.5 as your suspected non-compliance estimate (n_A) and maximize it (absolute value of $\tilde{n}_y$ - 0.5) as much as practicable. Selection of an appropriate value for $\tilde{n}_y$ will reduce sample sizes needed to obtain a given confidence limit (Figure 2). Since a violators desire to reply truthfully may decline if $\tilde{n}_y$ is chosen too close to zero, a guideline is to aim for a value around 0.10 or 0.90. If using the contamination design, this proportion can be easily generated in the randomization device. Alternatively, investigators should select an unrelated question in which the proportion of yes responses will approximate these values. The probability of an individual respondent being asked the sensitive question (P) should fall in the vicinity of 0.20 t .10 or 0.80 t 0.10.

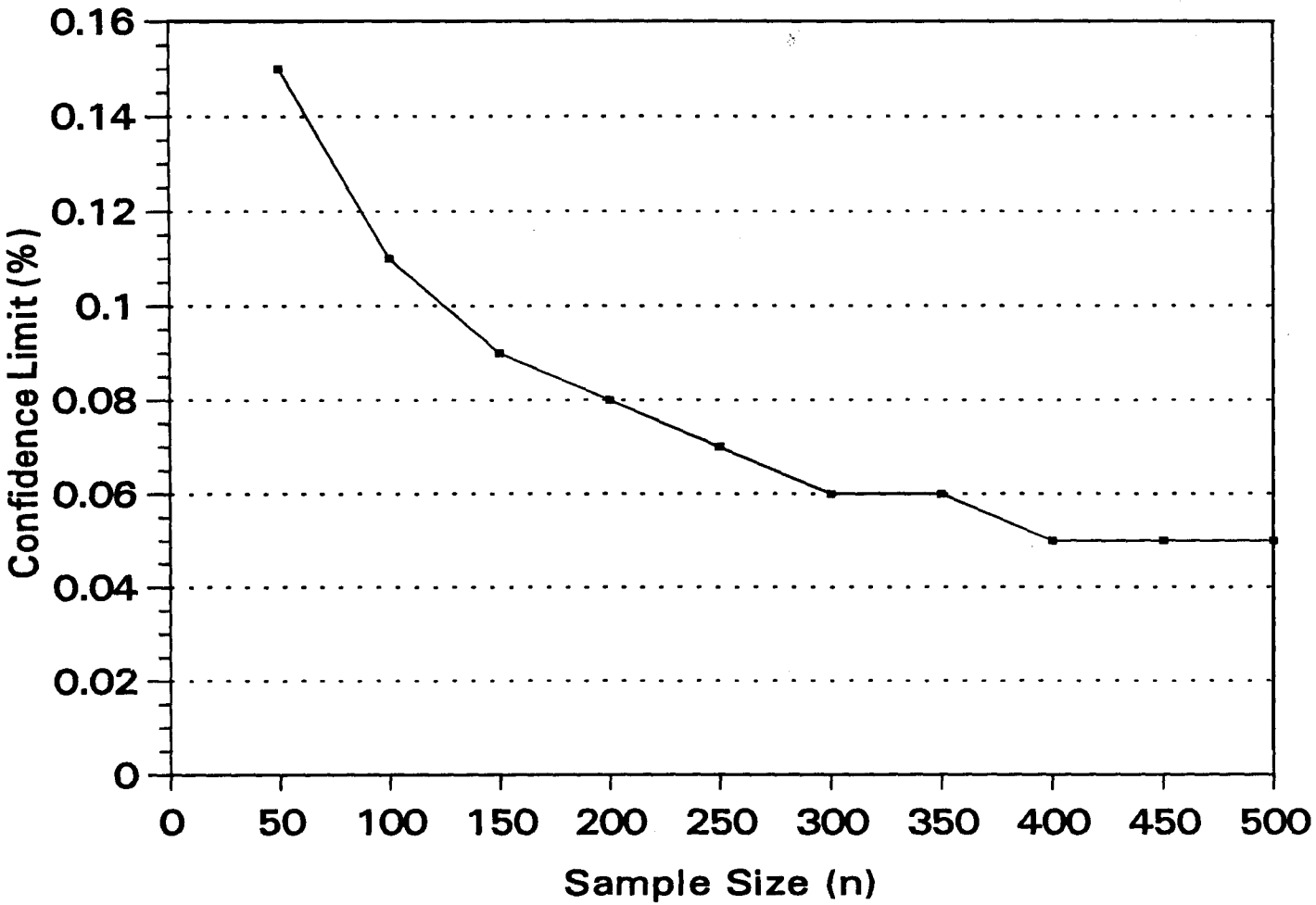

Figure 1. Effects of sample size on confidence limits for a random response survey assuming a 3% non-compliance rate and π_Y = 50%. π_Y the proportion of respondents with the non-sensitive attribute.

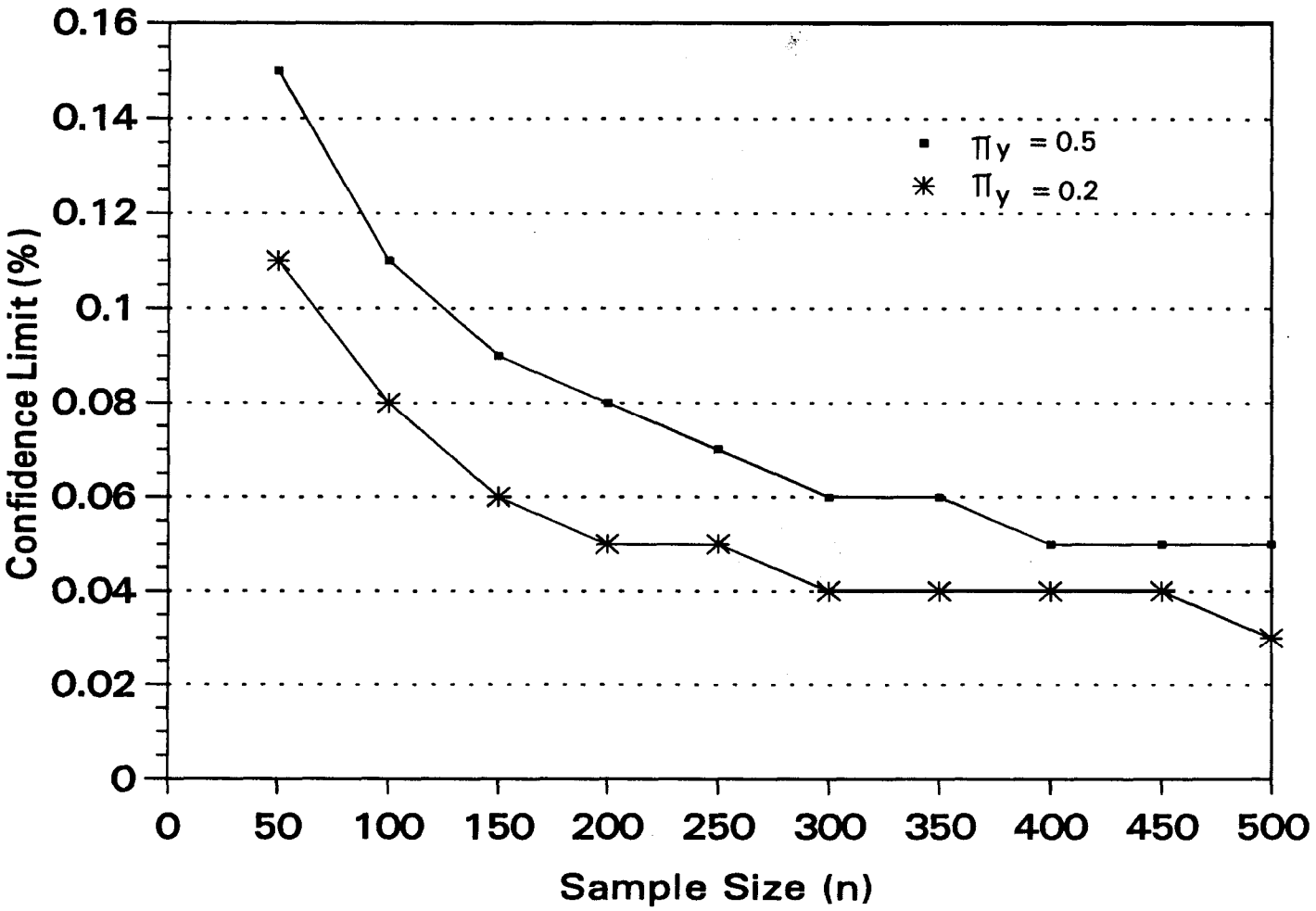

Figure 2. Effects of sample size and π_Y (the proportion of respondents with the non-sensitive attribute) on confidence limits for a random response survey assuming a 3% non-compliance rate.

There are several other possible limitations in using RR models for our purposes. Randomly contacting enough anglers in lightly-fished waters may increase survey costs substantially. We made no attempt to do so this year but will have to in the future if inferences about compliance for the entire season are to be valid. Perhaps the best approach to this problem would be to select interview days at random and then attempt to interview every angler observed on those days (Smith and Smeltzer 1991).

It is also possible that IDFG personnel may simply not be able to convince violators to answer truthfully. Enforcement of fish and game laws is one of the most visible aspects of wildlife agencies and it may be difficult to assure some violators that IDFG researchers are not interested in individual responses. The fear that somehow their responses could result in a ticket despite privacy protection mechanisms could be very hard to overcome. Locander et al. (1974) as reviewed by Horvitz et al. (1976) reported on the effects of question threat on response bias in surveys. The magnitude of response bias was statistically significant along the stigmatizing threat dimension, being lowest for voter registration and greatest for a drunken driving charge.

Wright (1980) suggested that RR surveys should not be done by fish and wildlife personnel for this reason. On the Coeur d'Alene River we attempted to overcome this fear by interviewing anglers in private vehicles and "civilian" clothes. This seemed to only create confusion since we did inform them we were IDFG employees. Also, some anglers were reluctant to have their fishing interrupted by a "civilian". We eventually settled on using tee-shirts with a small logo, only; no other types of uniform apparel was used.

We believe that "uniform shock" or general fear of IDFG personnel may be mitigated by judicious selection of interview personnel. It has been demonstrated that individual interview personnel can influence survey responses and ultimately study results (Frey 1989). This would seem particularly true of RR surveys. The selection of people who can interact easily with the public and can honestly assure respondents of their lack of interest in individual answers should reduce the incidence of dishonest responses. Prospective interview personnel with a strong interest in enforcement activities will probably not be very convincing and should be avoided.

Another reason actual violators may not want to answer truthfully would be the fear that high stream-wide violation rates may result in stepped-up law enforcement efforts in general. Results from past RR surveys on topics with much more stigmatizing potential suggest that members of a stigmatizing group such as drug users will in fact cooperate with RR surveys. One would expect that fear of stepped-up enforcement activities in these instances would be great but RR results have been validated against true known proportions (Horvitz et al. 1976).

New variations of RR (Fox and Tracy 1986) would allow not only for the collection of binomial data (proportion of violators) but also for the quantification of average numbers of fish illegally harvested per respondent. This quantitative technique is a contamination design that provides privacy protection by using a numeric distribution of "forced" responses similar in range to the suspected violation numbers. This model should be investigated in the future.

The use of RR surveys by IDFG could provide several benefits. An important one would be to assess where violations with special regulations are common enough to impede attainment of management goals or population potential. Results could also aid in prioritization of enforcement effort. Perhaps the biggest benefit would be to examine the demographics of violators to allow focus of education efforts on appropriate populations (Smith 1989). While discussions in this report have centered on fishing, the technique has potential in game management as well. Estimates of total numbers of animals poached by game management unit could be derived.

Non-compliance with proposed fishing regulations has often been ignored in past modeling efforts. Lack of public acceptance could be an important factor in population response to special regulations (Gigliotti and Taylor 1990; Paragamian 1984; Lewynsky 1986). Increasing dependence on special regulations to manage wild and trophy fisheries (IDFG 1991) will result in more need to educate anglers on the importance of compliance to attain management goals. Random response techniques show promise as a method to examine the importance of regulation non-compliance in our fisheries.

RECOMMENDATIONS

1. Conduct full scale RR surveys to estimate non-compliance on at least two Idaho special regulation waters. Validate the results with surrepticious observations.

2. Limit questions to the last fishing trip to allow for estimates of non-compliance impacts based on angler days.

3. Avoid use of a standard departmental uniform whenever possible to minimize negative bias from violators fearful of telling the truth. Use the minimum amount of departmental clothing necessary to maintain respect in the interview.

ACKNOWLEDGEMENTS

Dwain Lowry assisted with orientation in the Coeur d'Alene drainage and provided data on his contacts. Daniel Horvitz of the Triangle Research Institute provided tutoring on the intricacies of Random Response.

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